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Chairman, Subcommittee on Research
and Development, Committee on Armed
Services, House of Representatives

August 1990

DEFENSE RESEARCH

Information on Selected University Research Projects



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August 14, 1990

The Honorable Ronald V. Dellums
Chairman, Subcommittee on Research and Development
Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

As requested, we have obtained specific information on 17 selected defense research projects. You had expressed concern about the general lack of readily available detailed data on such projects. Each of the 17 projects you identified were either congressionally mandated or established by the Army. For each project, we obtained information on how it was established, the status of its funding and extent of expenditures, and the manner by which the Department of Defense (DOD) provides oversight.

Results in Brief

Nine projects were established by the Army through the University Research Initiative (URI) Program and two projects were established by the Army outside the URI Program. Six projects were established by the Congress as set-asides in DOD appropriations laws and are administered by the Army, Defense Nuclear Agency, or the Defense Advanced Research Projects Agency.

These 17 projects were funded in three major areas: (1) research, (2) equipment, and (3) fellowships. Research-related costs comprised the majority of funding for 15 projects. Expenditure data was not available for the other two projects that were recently established by congressional set-asides. Total cumulative expenditures identified by the universities for 15 of the 17 projects as of September 30, 1989, were approximately \$62 million. The amount of funding provided to universities for fellowship and equipment grants was approximately \$22 million.

A primary purpose of DOD's oversight of university research is to examine the relevance of research to its needs and to minimize or prevent duplication. The Army, for example, questioned the relevance of some of the research topics being pursued under one URI project and recommended refocusing certain research on another project.

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Background

In fiscal year 1988, all federal agencies obligated¹ about \$57 billion for research and development. DOD obligated about \$35 billion of this amount, with the majority of this funding supporting weapons development efforts. DOD provided \$3.2 billion for basic and applied research and awarded universities about \$729 million of this amount.²

Currently, DOD funds university research largely through two programs—Defense Research Sciences and URI. The Defense Research Sciences program emphasizes traditional single-investigator research activities, where typically one professor works with a small group of post-doctoral and graduate students. The typical Defense Research Sciences contract or grant is for a period of 3 to 5 years, with an average value of about \$100,000. Approximately 95 percent of DOD's funding for university research is provided for single-investigator projects. The projects we were asked to review, however, were primarily funded under the URI Program and through congressional set-asides.

The URI Program was initiated by DOD in 1986 to enhance the capabilities of universities to perform research and to educate scientists and engineers in disciplines that support technologies important to national defense. The program emphasizes a multidisciplinary (science and engineering) approach to research. Research activities are typically funded for 3 to 5 years at \$500,000 or more annually per project.

The Congress has set aside funding of approximately \$300 million in statute or in report language since 1986, directing DOD to award the funds to various universities for specific research or facilities construction.

Establishment of Projects

DOD generally must use competitive procedures to award contracts and grants to colleges and universities for the performance of research, development, or the construction of facilities.³ However, the Competition in Contracting Act permits certain exceptions, such as in cases where it is necessary to award a contract to a certain institution for an essential engineering, research, or development capability. Of the 17

¹Obligations are amounts for orders placed, contracts awarded, services received, and similar transactions during a given period, regardless of when funds were appropriated and when future payment is required.

²Data from National Science Foundation: Federal Funds for Research and Development—Detailed Historical Tables: Fiscal Years 1955-90

³10 U.S.C. 2361 (a).

projects we reviewed, 13 projects were established through competitive procedures, and 4 projects were established non-competitively.

Agencies can satisfy the requirement for competition in awarding contracts for basic research through a competitive process in which award results from a broad agency announcement and a peer or scientific review. The Federal Acquisition Regulation requires the broad agency announcement to be general in nature, identifying areas of research interest, including criteria for selecting proposals and soliciting the participation of all offerors capable of satisfying the government's needs.⁴ Contracts for 11 projects we examined were awarded based on broad agency announcements. The request for proposals is another form of solicitation sometimes used for obtaining university research proposals. Two projects we examined were established as a result of requests for proposals.

The 13 competitively awarded projects included 9 projects established in response to a broad agency announcement as centers under the Army's URI Program; 1 project was established in response to a request for proposal; and 3 were established as congressional set-asides for research projects to be conducted at unspecified universities.

Of the four projects awarded non-competitively, three were established by congressional set-asides and one was established by agreement between the Superintendent of the U.S. Military Academy at West Point and the Vice Chief of Staff of the Army. Appendix I provides more information on the various methods and examples of projects established by each method.

Project Expenditures

Table 1 summarizes the amount of expenditures reported by DOD at the end of fiscal year 1989 for the three types of projects we examined.

⁴Federal Acquisition Regulation 6.102(d)(2).

Table 1: Project Outlays^a As of September 30, 1989

Dollars in thousands

Type of outlay	URI Army	Percent	Non-URI Army	Percent	Set-asides ^b	Percent	Total	Percent
Research ^c	\$26,757	(55)	\$8,556	(100)	\$26,267	(100)	\$61,580	(73)
Fellowship grants	10,009 ^d	(20)	0	(0)	0	(0)	10,009	(12)
Equipment grants	12,428 ^e	(25)	0	(0)	0	(0)	12,428	(15)
Total^f	\$49,194	(100)	\$8,556	(100)	\$26,267	(100)	\$84,017	(100)

^aThe dollar amounts included in the table represent historical amounts that have not been adjusted for inflation.

^bExpenditure data were only available for four of six congressional set-asides. DOD has not yet identified expenditures for the remaining two set-asides.

^cExpenditures for research represent the amounts spent by universities on research-related activities, salaries, indirect costs, materials, supplies, and equipment.

^dThese expenditures represent the amount of grant funds the Army has provided to universities for fellowships.

^eThese expenditures represent the amount of grant funds the Army has provided to universities for equipment.

^fAll Army URI projects we examined began within the first 4 months of fiscal year 1987 and represent the largest percentage of total expenditures as of September 30, 1989. Four of the six set-aside projects we examined began after February 1989.

Source: DOD.

See appendix II for detailed information on project expenditures.

Oversight of Projects

According to DOD, the primary purposes of its oversight of university research are to assess the relevance of research to DOD's requirements and minimize or prevent duplication of research. To accomplish these tasks, DOD officials convene oversight panels for individual research projects. The Army, for example, established an oversight panel for each URI project to formally monitor the research. Panel members typically include representatives from the Army Research Office (ARO), Army laboratories, DOD laboratories, and, in some cases, private industry. The panels meet at least annually to assess the progress of research in terms of technical merit and relevance to the Army. In addition to such panels, DOD technical monitors make periodic site visits to universities and review university progress reports. Those responsible for oversight were generally satisfied with the direction and conduct of the Army research projects we examined.

One oversight panel, however, recommended to ARO, which manages university research for the Army, that certain research tasks be discontinued at the Advanced Construction Technology Center at the University of Illinois because the center's oversight panel did not consider them relevant to Army research needs. ARO's technical monitor informed university researchers of these recommendations and required strong, written justification if researchers decided to pursue these research areas. Another oversight panel recommended that certain research be refocused at the University of Wisconsin's Center for Advanced Propulsion Systems to fit in with the balance of the center's research program. In addition, an ARO technical monitor expressed concern about an apparent lack of "synergism" or creative cooperation at Colorado State University's Geosciences Center. The monitor also requested that the university discontinue research in an area that did not appear to be part of the original work statement. He has asked the university for a written response.

In overseeing the Photonics Research Center at West Point, ARO officials observed that the center had not spent all of its fiscal year 1989 funds by the end of that particular year. Consequently, ARO has delayed providing additional funds in fiscal year 1990 until the center requires such funding. A project review team for the Florida State University System's Advanced Microelectronics and Materials Program noted progress in many research areas, but observed that there were a number of disconnected efforts that made the program seem more like a National Science Foundation funded single investigator effort instead of a focused center program. See appendix III for a more detailed discussion of project oversight by the Army and defense agencies.

Scope and Methodology

We were specifically asked to obtain information on 17 projects—11 referred to by the Army as "centers,"⁵ and 6 funded through congressional set-asides through the DOD appropriations process. The research efforts we examined were funded as projects of limited duration, including those referred to as "centers."

Our work was limited to obtaining factual information relative to the 17 projects; we did not assess the research nor the DOD selection process. We determined the purpose and funding of the projects by examining contract and grant documents, and by interviewing DOD technical representatives. With respect to grants awarded to universities for equipment

⁵The Army is the only military service that specifically funds university research centers.


and fellowships, we examined DOD documents that recorded the payment to the universities for equipment and fellowships.

We interviewed officials responsible for overseeing the centers and examined research contract and grant files at the Office of the Secretary of Defense, ARO, Defense Advanced Research Projects Agency, Defense Nuclear Agency, Army Research Institute, Army Medical Research Acquisition Activity, and Massachusetts Institute of Technology. We obtained funding and expenditure data by examining financial documents provided by DOD. We did not verify the accuracy of this data. DOD provided funding data and cumulative expenditures as of September 30, 1989, for 15 projects. Expenditure data was not available for two centers recently established by congressional set-asides.

We did not obtain written agency comments on this report. However, we discussed the information contained in this report with DOD representatives and incorporated their comments as appropriate. Our review was performed between August 1989 and March 1990.

We are sending copies of this fact sheet to interested congressional committees, the Director of the Office of Management and Budget, and the Secretary of Defense. Copies will be made available to others on request. Please contact me at (202) 275-8400 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix IV.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Paul F. Math". The signature is stylized with a large, looping initial "P" and a distinct "M".

Paul F. Math
Director of Research, Development, Acquisition,
and Procurement Issues

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Abbreviations

ARO	Army Research Office
DOD	Department of Defense
MIT	Massachusetts Institute of Technology
URI	University Research Initiative
USC	University of Southern California

Establishment and Selection of Research Projects

This appendix describes various methods of establishing and selecting research university research projects, including broad agency announcements, requests for proposals, congressional set-asides, and internal service agreements. It also provides examples of selected projects established by each method. Table I.1 provides a list of the 17 research projects considered during our review.

Table I.1: University Research Centers and Projects Reviewed

Title	University	Solicitation ^a	Competition
Army URI Centers			
Intelligent Control Systems	MIT/Brown/Harvard ^b	Announcement	Competitive
Geosciences Research	Colorado State	Announcement	Competitive
Fast Transient Processes	USC ^c	Announcement	Competitive
Opto-Electronic Systems	Rochester	Announcement	Competitive
High-Frequency Microelectronics	Michigan	Announcement	Competitive
Biotechnology	Cornell	Announcement	Competitive
Advanced Construction Technology	MIT	Announcement	Competitive
Advanced Construction Technology	Illinois-Urbana	Announcement	Competitive
Advanced Propulsion Systems	Wisconsin-Madison	Announcement	Competitive
Army Non-URI Funded Centers			
Photonics Research	Military Academy	Unsolicited	Noncompetitive
Mathematical Sciences	Cornell	Proposal	Competitive
Congressional Set-Aside Projects and Centers			
Bioenvironmental Hazards Research Program	Tulane/Xavier	Unsolicited	Noncompetitive
High Performance Computing Research Center	Minnesota	Proposal	Competitive
Advanced Microelectronics and Materials Program	Florida State University System	Unsolicited	Noncompetitive
Simulation and Training Technology Transfer Program	Central Florida	Announcement	Competitive
Optoelectronic Materials Center	USC ^c	Announcement	Competitive
Study of Factors Impacting Supply of Women and Minority Scientists, Engineers, and Technologists	Huston-Tillotson College	Unsolicited	Noncompetitive

^aAnnouncement refers to broad agency announcement; proposal refers to request for proposals.

^bMIT refers to Massachusetts Institute of Technology.

^cUSC refers to University of Southern California.

Background

DOD generally must award contracts and grants for university research and development activities using competitive procedures. The Competition in Contracting Act of 1984 requires that federal agencies procure property or services based on full and open competition.¹ According to

¹10 U.S.C. 2304.

the Federal Acquisition Regulation, this means that all responsible sources should be permitted to compete. However, statutory exceptions to this requirement exist, such as when

“ . . . it is necessary to award the contract to a particular source or sources in order to . . . establish or maintain an essential engineering, research, or development capability to be provided by an educational or other nonprofit institution or a federally funded research and development center.”

The Competition in Contracting Act defines competitive procedures as including the competitive selection of research proposals resulting from a general solicitation and a peer review or scientific review of the proposals.²

The Federal Acquisition Regulation permits agencies to procure research by

- issuing “[a] broad agency announcement that is general in nature identifying areas of research interest, including criteria for selecting proposals, and soliciting the participation of all offerors capable of satisfying the Government’s needs” and
- conducting “a peer or scientific review.”³

Federal agencies often use broad agency announcements for soliciting basic research proposals. Occasionally, agencies will issue requests for proposals, another form of solicitation, when soliciting research proposals from universities.

Selection of University Research Projects

DOD selects research projects by evaluating the scientific merit and DOD relevance of proposals submitted by universities. According to DOD, the requirement to ensure relevance results from the “Mansfield Amendment” that was first enacted in 1970. It states that DOD cannot fund any research project or study unless the Secretary of Defense determines that there is “a potential relationship to a military function or operation.”

Set-Aside Projects

The Congress has directed in law or report language, since fiscal year 1986, that DOD award approximately \$300 million to universities for

²10 U.S.C. 2302 (2)(b).

³Federal Acquisition Regulation, section 6.102 (d)(2).

research and/or facilities construction. We reviewed six projects established through such funding set-asides. The Congress designated the university, research area, and funding level for three of the projects. For the remaining three, the Congress only specified the research areas and funding levels. Various universities competed for these awards.

In the section below, we describe the establishment of two of these projects, one in which congressional legislation provided for set-aside funding for a specific university and research area, and one in which funding was set aside for the research area only and universities competed for the funding. We selected these projects due to their high dollar value and because they are representative of the two types of set-aside projects.

Advanced Microelectronics and Materials Program

The fiscal year 1988 Appropriations Act for DOD set aside funding of \$25 million for

“... a program of advanced compound and other semiconductor research, and related materials research at university centers of excellence for design and test of semiconductors, micro fabrication techniques . . . , and materials technologies sciences . . .”⁴

The conference report on the fiscal year 1988 DOD Appropriations Act stated that preference should be given

“... to a public university system in which: (1) . . . centers of excellence are already in place and functioning . . . ; (2) a strong board of regents oversees the centers of excellence, and is positioned to coordinate the various elements of the research program; and (3) a critical scientific infrastructure is in place, including established research facilities and a functioning supercomputer . . . as well as a superconducting linear accelerator . . .”⁵

In May 1988, the State University of Florida System submitted an unsolicited proposal to the Defense Advanced Research Projects Agency for research in advanced microelectronics and materials that met the above criteria. The agency subsequently awarded a grant to the Florida university system based on the restrictive language of the appropriations law and conference report, a review of public university systems, and the agency’s conclusion that the Florida university system best fulfilled the legislative criteria.

⁴Public Law 100-202, 101 Stat. 1329-59.

⁵H.R. Conf. Rept. No. 498, 100th Cong., 1st sess., 63 (1987).

High Performance Computing
Research Center

A member of Congress approached the Army with a proposal to procure a supercomputer for the University of West Virginia about 4 years ago. ARO agreed with the concept of establishing a supercomputing center at an educational institution and procuring the necessary hardware and recommended that location of the center be decided through an open competition among universities. The Congress eventually approved this approach. Rather than earmarking funds for a particular university, the Congress set aside funding for a supercomputing research center that was to be awarded competitively.⁶ The review process, according to an ARO official, was very comprehensive and intensive and took about 4 months. A source selection evaluation board, including representatives from Army and Air Force laboratories, examined proposed research areas, hardware acquisition plans, and the supporting university infrastructure.

The selection board visited the six universities having the highest ranked proposals, and selected the University of Minnesota because its proposal

- demonstrated a well integrated program of research, hardware acquisition, and infrastructure support;
- addressed both conventional and advanced computing techniques;
- indicated a strong collection of interdisciplinary groups (computer scientists, mathematicians, computational scientists, and engineers);
- contained a clear acquisition plan;
- had an excellent program for transfer of technology to Army sites; and
- had a well-developed plan for involving Historically Black Colleges and Universities and Minority Institutions (e.g., Howard University).

Establishment of Projects
Through Competitive
Procedures—Broad
Agency Announcements

Eleven of 17 projects we examined were established through competitive procedures involving broad agency announcements (2 of 6 congressional set-asides and the 9 URI projects were established through such announcements). Proposals submitted in response to broad agency announcements are primarily evaluated on technical merit, relevance to agency programs, and funding availability. Broad agency announcements are typically “open announcements” and universities can submit proposals at any time during the period the announcements remain open. DOD evaluates proposals as they are submitted by universities and funds those projects it believes will be useful to DOD. Thus, universities

⁶H.R. Conf. Rept. No. 1002, 100th Cong., 2d sess., 102 (1988).

vie for research funding, but do not necessarily compete against each other when responding to open announcements.

Nine research projects were established by the Army through a special broad agency announcement issued solely for the URI Program. In this case, universities competed for funding awards in a head-to-head competition. The broad agency announcement solicited proposals from universities in 10 research areas. Teams comprised of representatives from Army laboratories, ARO, the Navy, the Air Force, and the Defense Advanced Research Projects Agency evaluated the proposals. The teams evaluated the proposals in terms of several criteria, including

- scientific and/or technical merit;
- relevance to the Army;
- qualifications of principal investigators;
- past research accomplishments;
- offeror's capabilities, related experience, and facilities;
- fellowship selection and administration procedures; and
- procedures for exchange of information and personnel between the proposed center and Army laboratories.

The evaluation process consisted of several steps for each group of proposals submitted for each of the 10 research areas:

- The evaluation teams performed an initial screening and evaluated each proposal on the first three criteria noted above.
- The teams conducted a semi-final screening by evaluating and ranking the proposals on all of the above criteria, and then selected finalists for site visits.
- The teams then performed site visits, re-ranked the finalists, and made final recommendations.
- Program selection boards within the Army reviewed the final recommendations and reassessed the overall balance of research programs within the Army.
- Top management within the Army reviewed the recommendations of the program selection boards and a DOD-wide steering committee made the final award decisions.

Army Centers for Advanced
Construction Technology at the
University of Illinois and MIT

The Army centers for advanced construction technology at the University of Illinois and MIT are representative examples of the Army's use of a broad agency announcement to establish URI centers.

ARO received seven proposals from universities in the advanced construction technology area. The selection panel conducted site visits at the two universities whose proposals were ranked highest, the University of Illinois and MIT. After the site visits, the panel ranked MIT first in the scientific merit and fellowship procedures criteria. The panel ranked the University of Illinois first in the capabilities/facilities and information exchange criteria. In the remaining categories, the panel considered the two universities to have equal strengths. The panel, however, recommended that the center be established at MIT because of its slightly higher ranking in the scientific/technical merit area. The panel commented that the MIT center "would offer the greatest potential for providing a stronger science base for applications by the Army Corps of Engineers." The committee forwarded its recommendation to the Director of ARO and to the Department of the Army. Army headquarters, however, decided to award contracts to both universities. According to an ARO official, Army headquarters decided to fund both proposals since each university would cover a different area of advanced construction technology and, therefore, would not result in duplication of research.

Defense Advanced Research
Projects Agency and Army
Simulation and Training
Technology Transfer Program at
the University of Central Florida

The simulation and technology transfer program is an example of how DOD established a congressional set-aside research project.

DOD appropriations for fiscal year 1989 included a set-aside of \$5 million for specific research. The conference report stated that these funds should be used for

"... simulation and training technology transfer activities through the involvement of a university system with a strong base of experience in training and simulation technology transfer that can be quickly mobilized to meet the technology transfer needs of the Defense Department ..."⁷

The Army's Project Manager for Training Devices selected the University of Central Florida for this research program through a competitive evaluation of 12 university proposals accepted in response to a broad agency announcement issued by the Army's project manager. Central Florida ranked highest in terms of technical merit and relevance to DOD and was awarded contracts for research in three areas

- networking/communication technology,
- intelligent simulated forces, and
- aviation trainer technology.

⁷H.R. Rept. 100-1002, Sept. 28, 1988.

Establishment of Projects Through Competitive Procedures—Requests for Proposals

We examined two projects that were established as a result of requests for proposals. Requests for proposals are used to communicate government requirements to prospective contractors and to solicit proposals from them. They are sometimes used when the government is interested in procuring computer systems or other hardware or facilities in addition to basic research.

Army Center of Excellence in the Mathematical Sciences at Cornell University

The Army Center of Excellence in the Mathematical Sciences at Cornell University is a representative example of a project that was established through a request for proposals. A technical review committee consisting of university and Army experts evaluated 13 proposals submitted to ARO. The committee considered technical merit,⁸ facilities management, and costs when evaluating proposals. Following the evaluation of proposals, a team of ARO and Army laboratory scientists made preliminary site visits to four universities that ranked highest. The team selected the University of Chicago and Cornell University as finalists. Based on final site visits and its evaluation of technical areas, management, interdisciplinary activities, and plans for technical assistance and educational activities for the Army, ARO recommended Cornell University for the establishment of the Mathematical Sciences Center. ARO subsequently awarded a 5-year contract to Cornell University in January 1986 for the amount of \$12.4 million.

Establishment of Photonics Research Center Through Internal Service Agreement

The Photonics Research Center was unique in that it was the only project established through an internal agreement. On May 13, 1987, a Memorandum of Understanding was signed between the Vice Chief of Staff of the Army and the Superintendent of the U.S. Military Academy at West Point. The intended purposes of the center were to

- provide the Army with basic and applied research on laser technology considered important for future Army missions;
- train technical officers in research, development, and application of laser technologies; and
- enhance the quality of education at the academy.

The Army's Director for Research and Technology determined that a research proposal for the center submitted by the academy was within the photo-optics research area of ARO's fiscal year 1987 broad agency

⁸In evaluating technical merit of proposals, the selection committee considered, among other things—originality, relevance to Army's interests, and the qualifications and experience of those who would be performing research.

**Appendix I
Establishment and Selection of
Research Projects**

announcement. Funding of \$1 million was initially provided for the center through a 1-year contract in fiscal year 1988 with options for continued support for 4 additional years at the same annual level of funding.

Purpose, Funding, and Expenditures of University Research Projects

This appendix provides information on the purpose, funding,¹ and cumulative expenditures as of September 30, 1989, of the 17 projects we examined. The expenditure amounts included in the project tables represent historical costs that have not been adjusted for inflation. Table II.1 provides a summary of individual research project outlays.

Table II.1: Project Outlays as of September 30, 1989

Title	University	Research costs	Fellowship grants	Equipment grants
Army URI Centers				
Intelligent Control Systems	MIT/Brown/Harvard	\$4,455	\$1,290	\$806
Geosciences Research	Colorado State	3,280	1,035	1,029
Fast Transient Processes	USC	1,054	341	790
Opto-Electronic Systems	Rochester	2,833	1,913	2,606
High-Frequency Microelectronics	Michigan	3,591	1,609	2,027
Biotechnology	Cornell	3,601	815	1,000
Advanced Construction Technology	MIT	2,645	1,217	1,365
Advanced Construction Technology	Illinois-Urbana	2,460	942	1,387
Advanced Propulsion Systems	Wisconsin-Madison	2,838	847	1,418
Subtotal		26,757	10,009	12,428
Army Non-URI Funded Centers				
Photonics Research	Military Academy	965	N/A	N/A
Mathematical Sciences	Cornell	7,591	N/A	N/A
Subtotal		8,556	0	0
Congressional Set-Aside Projects and Centers				
Bioenvironmental Hazards Research	Tulane/Xavier	419	N/A	N/A
High Performance Computing Center	Minnesota	0	N/A	N/A
Advanced Microelectronics and Materials Program	Florida State University System	23,294	N/A	N/A
Simulation/Training Technology	Central Florida	332	N/A	N/A
Optoelectronic Materials Center	USC	0	N/A	N/A
Study of Factors Impacting Supply of Women and Minority Scientists, Engineers, and Technologists	Huston-Tillotson College	2,222	N/A	N/A
Subtotal		26,267	0	0
Total		\$61,580	\$10,009	\$12,428

In fiscal year 1988, DOD obligated about \$3.2 billion for basic and applied research. About \$729 million of this amount was provided to universities for research and development activities. For the 5-year period

¹Funding data is included under the category "Award Value" in the tables contained within this appendix.

ending September 30, 1988, DOD increased its funding of university research by about 19 percent after adjustments for inflation.

The following tables show research costs by categories that we identified in each research contract. Universities are not required to consistently report the purpose of their expenditures when submitting payment vouchers for costs incurred. For example, in the case of "student-related costs," some universities identified specific accounts that were charged (undergraduate salaries, graduate tuition, research assistant costs, and stipends). Other universities did not identify any student-related costs when submitting vouchers.

The column "costs incurred" refers to those costs for which the government is liable for payment, but which the government may not yet have paid in full. "Award value" is the value of a contract or grant plus additional cost modifications. The amount of costs incurred did not exceed the award value of a contract or grant. The Army provided fellowship and equipment grants in addition to research funding for centers supported under the URI Program. Because the Army generally provided full funding to universities for these grants shortly after the start of a project, we only provided the total award value of the grants in the cost tables, not specific costs incurred. The "award period" is the period of performance stipulated in the contract or grant and adjusted as necessary by contract or grant modifications.

Center for Study of Intelligent Control Systems

MIT

Purpose

To perform research that will contribute to the development of sophisticated guidance, command, communication, and control systems.

Table II.2: Center for Study of Intelligent Control Systems— Funding and Expenditures (As of 9/30/89)

Dollars in thousands			
	Costs incurred	Award value	Percent of total
Research contract ^a		\$5,400	72
Salaries/fringe benefits	\$1,497		
Indirect costs	1,166		
Student-related costs	197		
Materials/services	174		
Other ^b	1,421		
Total	\$4,455		
Equipment grant		806	11
Fellowship grant		1,290	17
Total		\$7,496	100

^aAward period: 10/1/86 to 11/30/89.

^bIncludes subcontracts of \$1,257,164 (88% of other costs).

Source: ARO.

Center for Geosciences Research

Colorado State University

Purpose

To develop new analysis tools to improve understanding of hydrology and meteorology in the battlefield environment.

**Table II.3: Center for Geosciences
Research—Funding and Expenditures**
(As of 9/30/89)

Dollars in thousands			
	Costs incurred	Award value	Percent of total
Research contract ^a		\$3,620	64
Salaries/fringe benefits ^b	\$1,719		
Indirect costs	861		
Student-related costs ^c	0		
Materials/supplies and equipment	98		
Other ^d	602		
Total	\$3,280		
Equipment grant		1,029	18
Fellowship grant		1,035	18
Total		\$5,684	100

^aAward period: 10/1/86 to 1/15/90.

^bPersonnel costs of \$1,719,214 categorized under salaries/fringe benefits.

^cNo student-related costs were identified by the university.

^dIncludes unidentified other direct costs of \$398,553 (66% of other costs).

Source: ARO.

Center for the Study of Fast Transient Processes

USC

Purpose To formulate faster burning and lower vulnerability propellants and explosives.

Table II.4: Center for the Study of Fast Transient Processes— Funding and Expenditures (As of 9/30/89)

Dollars in thousands			
	Costs incurred	Award value	Percent of total
Research contract ^a		\$1,494	52
Salaries/fringe benefits	\$379		
Indirect costs ^b	394		
Student-related costs ^c	0		
Materials/supplies and equipment	193		
Other ^d	88		
Total	\$1,054		
Equipment grant		1,014	36
Fellowship grant		341	12
Total		\$2,849	100

^aAward period: 10/1/86 to 11/30/90.

^bOverhead costs of \$393,542 categorized as indirect costs.

^cNo student-related costs were identified by the university.

^dIncludes other materials/supplies-subcontracts of \$63,654 (72% of other costs).

Source: ARO.

Center for Opto-
Electronic Systems
Research

University of Rochester

Purpose

To enhance the Army's technology base in lasers, signal processing, optical system design, and display design.

**Table II.5: Center for Opto-Electronic
Systems Research—Funding and
Expenditures** (As of 9/30/89)

Dollars in thousands			
	Costs incurred	Award value	Percent of total ^b
Research contract ^a		\$4,312	49
Salaries/fringe benefits	\$1,036		
Indirect costs	1,038		
Student-related costs ^c	0		
Supplies and equipment	577		
Other ^d	182		
Total	\$2,833		
Equipment grant		2,606	30
Fellowship grant		1,913	22
Total		\$8,831	100

^aAward period: 10/1/86 to 9/30/90.

^bPercentages were rounded up to nearest whole numbers, thus, total exceeds 100 percent.

^cNo student-related costs were identified by the university.

^dIncludes unidentified other direct costs of \$114,050 (63% of other costs).

Source: ARO.

Center for Research on High-Frequency Microelectronics

University of Michigan

Purpose

To conduct research on new concepts, techniques, and approaches for enhancing the capabilities of solid-state devices and integrated circuits for very high-speed, high data rate communication systems, and command and control systems.

Table II.6: Center for Research on High-Frequency Microelectronics—Funding and Expenditures (As of 9/30/89)

Dollars in thousands			
	Costs incurred	Award value	Percent of total ^b
Research contract ^a		\$4,987	58
Salaries/fringe benefits	\$1,783		
Indirect costs	1,308		
Student-related costs ^c	0		
Supplies and equipment	459		
Other ^d	41		
Total	\$3,591		
Equipment grant		2,027	23
Fellowship grant		1,609	19
Total		\$8,623	100

^aAward period: 12/15/86 to 12/14/90.

^bPercentages were rounded up to nearest whole number, thus, total exceeds 100 percent.

^cNo student-related costs were identified by the university.

^dIncludes travel expenses of \$40,001 (99% of other costs).

Source: ARO.

Center of Excellence in Biotechnology

Cornell University

Purpose

To conduct research on protein structure and function, with an emphasis on enzymes. The Army has identified biotechnology as a critical technology area.

**Table II.7: Center of Excellence in
Biotechnology—Funding and
Expenditures** (As of 9/30/89)

Dollars in thousands			
	Costs incurred	Award value	Percent of total
Research contract ^a		\$5,269	72
Salaries/fringe benefits	\$1,295		
Indirect costs	1,369		
Student-related costs	48		
Materials/supplies and equipment	662		
Other ^b	227		
Total	\$3,601		
Equipment grant		1,000	14
Fellowship grant		1,017	14
Total		\$7,286	100

^aAward period: 12/22/86 to 12/21/90.

^bIncludes service and repair costs of \$164,017 (72% of other costs).

Source: ARO.

Advanced Construction Technology Center

University of Illinois -
Urbana

Purpose

To assist the Army by researching ways to reduce costs for military construction that is maintainable and survivable in severe environments.

**Table II.8: Advanced Construction
Technology Center—Funding and
Expenditures** (As of 9/30/89)

Dollars in thousands			
	Costs incurred	Award value	Percent of total ^b
Research contract ^a		\$3,701	57
Salaries/fringe benefits	\$1,393		
Indirect costs	961		
Student-related costs ^c	0		
Materials/supplies and equipment	130		
Other ^d	161		
Total	\$2,645		
Equipment grant		1,607	24
Fellowship grant		1,217	19
Total		\$6,525	100

^aAward period: 1/20/87 to 1/19/91.

^bPercentages were rounded up to nearest whole numbers, thus, total exceeds 100 percent.

^cNo student-related costs were identified by the university.

^dIncludes \$105,131 for services (65% of other costs).

Source: ARO.

Center for Advanced Construction Technology

MIT

Purpose

To enhance the productivity and capabilities of construction resources needed to support the Army in such research areas as materials and structures, automation and robotics, and facility performance and maintainability.

**Table II.9: Center for Advanced
Construction Technology— Funding and
Expenditures** (As of 9/30/89)

Dollars in thousands			
	Costs incurred	Award value	Percent of total
Research contract ^a		\$3,839	62
Salaries/fringe benefits	\$1,089		
Indirect costs	925		
Student-related costs	298		
Materials/services	115		
Other ^b	33		
Total	\$2,460		
Equipment grant		1,441	23
Fellowship grant		942	15
Total		\$6,222	100

^aAward period: 1/15/87 to 1/14/91.

^bIncludes travel of \$21,961 (66% of other costs).

Source: ARO.

Center for Advanced Propulsion Systems

University of Wisconsin- Madison

Purpose

To enhance the development of lightweight, compact, and fuel efficient powerplants for Army vehicles and aircraft.

**Table II.10: Center for Advanced
Propulsion Systems—Funding and
Expenditures (As of 9/30/89)**

Dollars in thousands			
	Costs incurred	Award value	Percent of total
Research contract ^a		\$3,852	63
Salaries/fringe benefits	\$1,473		
Indirect costs ^b	822		
Student-related costs	101		
Materials/supplies and equipment	236		
Other ^c	206		
Total	\$2,838		
Equipment grant		1,418	23
Fellowship grant		847	14
Total		\$6,117	100

^aAward period: 10/1/86 to 11/30/90.

^bOverhead costs of \$822,242 categorized as indirect costs.

^cIncludes unidentified other direct costs of \$154,297 (75% of other costs).

Source: ARO.

Photonics Research Center

U.S. Military Academy at West Point

Purpose

To perform basic and applied research on various aspects of laser technology.

**Table II.11: Photonics Research
Center—Funding and Expenditures** (As
of 9/30/89)

Dollars in thousands		
	Costs incurred	Award value
Research contract ^a		\$2,000
Salaries/fringe benefits	\$2	
Indirect costs ^b	0	
Student-related costs ^c	0	
Supplies and equipment	346	
Other ^d	617	
Total	\$965	

^aThe center was established on May 13, 1987.

^bNo indirect costs were identified by the Military Academy.

^cNo student-related costs were identified by the Military Academy.

^dIncludes contract services of \$576,325 (93% of other costs).

Source: ARO.

Center of Excellence in Mathematical Sciences

Cornell University

Purpose

To conduct research in applied and numerical analysis, physical mathematics, computing, statistics, and applied probability.

**Table II.12: Center of Excellence in
Mathematical Sciences— Funding and
Expenditures** (As of 9/30/89)

Dollars in thousands		
	Costs incurred	Award value
Research contract ^a		\$12,419
Salaries/fringe benefits	\$3,213	
Indirect costs	2,671	
Student-related costs	721	
Materials/supplies and equipment	27	
Other ^b	959	
Total	\$7,591	

^aAward period: 1/1/86 to 3/31/91.

^bIncludes conferences and seminars of \$631,474 (66% of other costs).

Source: ARO.

Advanced Microelectronics and Materials Program

State University System of Florida

Purpose

To coordinate the research efforts of 16 universities, as well as industrial research groups, in a project involving microelectronics, optoelectronics, superconductivity, and advanced composite materials.

**Table II.13: Advanced Microelectronics
and Materials Program— Funding and
Expenditures** (As of 9/30/89)

Dollars in thousands		
	Costs incurred	Award value
Research grants ^a		\$44,300
Salaries/fringe benefits	\$5,517	
Indirect costs	3,624	
Student-related costs ^b	0	
Equipment	11,530	
Other ^c	2,623	
Total	\$23,295	

^aAward period: 7/1/88 to 9/30/90.

^bNo student-related costs were identified by the university.

^cIncludes unidentified expenses of \$2,174,553 (83% of other costs).

Source: Defense Advanced Research Projects Agency.

Simulation and Training Technology Transfer Program

University of Central Florida

Purpose

To provide a low-cost simulation environment to conduct force-on-force training. Three subprojects are researching more effective and less expensive training techniques.

**Table II.14: Networking/Communication
Technology Subproject—Funding and
Expenditures** (As of 9/30/89)

Dollars in thousands		
	Costs incurred	Award value
Research contract ^a		\$1,741
Labor	\$62	
Indirect costs	36	
Other ^b	13	
Total	\$111	

^aAward period: 3/31/89 to 3/31/91.

^bIncludes travel costs of \$4,247.

Source: Naval Training Systems Center.

**Table II.15: Intelligent Simulated Forces
Subproject—Funding and Expenditures**
(As of 9/30/89)

Dollars in thousands		
	Costs incurred	Award value
Research contract ^a		\$1,627
Labor	\$55	
Indirect costs	31	
Other ^b	11	
Total	\$97	

^aAward period: 3/31/89 to 3/31/91.

^bIncludes travel costs of \$3,130.

Source: Naval Training Systems Center.

Appendix II
Purpose, Funding, and Expenditures of
University Research Projects

Table II.16: Aviation Trainer Technology Subproject—Funding and Expenditures
 (As of 9/30/89)

Dollars in thousands		
	Costs incurred	Award value
Research contract ^a		\$1,190
Labor	\$50	
Indirect costs	28	
Other ^b	46	
Total	\$124	

^aAward period: 3/31/89 to 3/31/91.

^bIncludes travel costs of \$4,548.

Source: Naval Training Systems Center.

Study to Determine and Test Factors Impacting Supply of Minority and Women Scientists, Engineers, and Technologists

Huston-Tillotson College

Purpose

To provide a knowledge base to improve recruitment and retention strategies of women and minorities in quantitatively based studies and careers in defense-related fields.

Table II.17: Study to Determine and Test Factors Impacting Supply of Minority and Women Scientists, Engineers, and Technologists—Funding and Expenditures
 (As of 9/30/89)

Dollars in thousands		
	Costs incurred	Award value
Research contracts and grants ^a		\$4,803
Salaries/fringe benefits	\$868	
Indirect costs	172	
Student-related costs ^b	0	
Equipment	19	
Other ^c	1,161	
Total	\$2,220	

^aAward period: 9/2/85 to 5/31/91.

^bNo student-related costs were identified by the college.

^cIncludes consortium intervention expenses of \$857,076 (74% of other costs).

Source: U.S. Army Medical Research Acquisition Activity.

Bioenvironmental
Hazards Research
Program

Tulane and Xavier
Universities

Purpose To study bioenvironmentally hazardous conditions that may be produced by DOD and its contractors during research, development, testing, operation, and maintenance of equipment and weapon systems, and effects of such conditions on DOD personnel, the civilian population, and the environment.

Table II.18: Bioenvironmental Hazards Research Program—Funding and Expenditures (As of 9/30/89)

Dollars in thousands		
	Costs incurred	Award value
Research contract ^a	\$419	\$33,000

^aAward period: 4/12/89 to 4/12/95.
Source: Defense Nuclear Agency.

Background Tulane and Xavier Universities were awarded a total of \$33 million in fiscal years 1988 and 1989 for this program (\$16.5 million in each fiscal year). The grant period of performance is 72 months or until funds are fully expended, whichever comes first. As of September 30, 1989, a total of \$418,891 had been spent by the universities. A detailed financial status report was due from the universities by mid-July 1990.

High Performance Computing Research Center

University of Minnesota

Purpose	To examine the use and acquisition of high performance computing systems, and user support at this center, other Army computing centers, and selected remote sites.
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Background	A contract was awarded to the University of Minnesota for this effort on August 25, 1989, for the amount of \$66.9 million. As of February 9, 1990, ARO, which is administering the contract, had not received any expenditure vouchers from the university for costs associated with the center.
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Optoelectronics Materials Center

USC

Purpose	To promote a university program with demonstrated capabilities for pursuing optoelectronics and photonics on a comprehensive basis to meet DOD needs.
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Background	The Defense Advanced Research Projects Agency awarded a contract to a consortium led by USC in May 1990 for the amount of \$10 million. At the conclusion of our review, no expenditures had been reported by the university.
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Army's and Defense Agencies' Oversight of University Research Projects

This appendix provides information on ARO, Defense Nuclear Agency, and Defense Advanced Research Projects Agency oversight of the university research centers and projects we examined. ARO, the Defense Advanced Research Projects Agency, and the Defense Nuclear Agency are responsible for monitoring the technical and programmatic performance of centers and projects to ensure compliance with the terms of research contracts and grants. We provide information on seven research projects to show how these agencies conduct oversight.

Process of Oversight

ARO, the Defense Nuclear Agency, and the Defense Advanced Research Projects Agency conduct oversight of university research in a variety of ways, including

- annual technical reviews by oversight committees,
- periodic site visits,
- reviews of university progress reports, and
- informal communications.

The oversight committees generally consist of representatives from the military services' research offices and laboratories, private industry, and the relevant university research community. The oversight committees advise and provide direction to the universities on their research goals. In addition, they assess the progress of university research annually and provide feedback to defense agency technical representatives on progress and problems, such as cases where specific research is not relevant to DOD's needs. The technical representatives, in turn, provide this feedback to university researchers.

The technical representatives also make site visits to the universities, review routine progress reports, and otherwise maintain less formal contact with the researchers through correspondence and the telephone.

Technical monitors from the Army and defense agencies were generally satisfied with the direction and conduct of the research that they oversee. In one case, however, evaluation panel members recommended to the technical monitor that specific research topics should be discontinued or refocused because they were not relevant to Army research needs. In addition, the technical monitor for one of the centers that ARO oversees was not pleased with the development of that center and recommended that the center revise its research activities in four areas.

**Oversight of Selected
Centers and Projects**

Our examination of seven selected centers and projects indicated how ARO and other defense agencies conduct oversight.

**Advanced Construction
Technology Center at the
University of Illinois**

ARO oversees this research center. The oversight panel conducted an annual assessment in October 1988 and recommended that two of the center's proposed tasks be discontinued because the panel did not consider them relevant to Army research needs.

In a letter to the center, ARO's technical monitor mentioned the panel's recommendation but left the final decision regarding the technical content of the research program and the distribution of various tasks to the center. The monitor, however, required strong, written justification if the research tasks recommended for deletion were retained.

An annual review and evaluation of the center was made in October 1989. During that evaluation, a very well planned and professionally delivered review of all current research tasks at the university was presented to the evaluation panel by center representatives, and the panel found the center's research to have good scientific merit and relevance.

**Center for Advanced Propulsion
Systems at the University of
Wisconsin**

ARO also oversees this center. The review panel reviewed the research activities supported under the center in August 1989, and evaluated the progress made at the center since its establishment in 1987. Although the unanimous consensus of the review team was that the research done at the center was of "high quality and is providing valuable results which will greatly benefit the development of advanced engines," there were two areas of research that the review team did not believe were as well focused as the balance of the program. The technical monitor recommended that the center place attention on engine materials and lubrication requirements for advanced, high performance engines and structure the program accordingly. In addition, the technical monitor identified the need for better program definition and possible redirection of research.

According to the technical monitor, however, the center presented their program at the Engineering Science Division Review on March 6, 1990, and gave appropriate attention to the weaknesses previously identified. The technical monitor was pleased with the corrective action the center had taken and said that an on-site review of the center's research activities was scheduled for June 1990.

Bioenvironmental Hazards
Research Program at Tulane and
Xavier Universities

The Defense Nuclear Agency oversees this research program. Congress set aside funding for Tulane and Xavier Universities to conduct this program. (See app. I.) The Defense Nuclear Agency operates this research program with the advice of a peer review group. The review group is knowledgeable of DOD's research requirements in the bioenvironmental hazards area and the capabilities of the two universities. Based on the group's guidance, the universities have submitted a number of preliminary research proposals to the agency for evaluation. As each proposal is evaluated, the universities will submit detailed proposals, which the review group will evaluate in 1990. At the current rate of project proposal submissions and approvals, Defense Nuclear Agency officials expect that it will take several review cycles to approve initial funding of \$10 million for the various research efforts under this program.

Advanced Microelectronics and
Materials Program at the State
University System of Florida

The Defense Advanced Research Projects Agency oversees this four-part program, which includes research in the areas of microelectronics, optoelectronics, superconductivity, and advanced composite materials. Separate topical reviews on each of the subprojects occur at least once a year at different times. In addition, each year a conference involving the researchers involved in the four subprojects and representatives from the agency is held to share information and discuss progress. A review was conducted at three Florida universities during January 16 to 18, 1990. The review team was generally pleased with the quality of research teams assembled by the universities, the facilities, and the technical advances being reported. The superconductivity project review team, however, noted that while significant progress has been made in a number of areas, the program has numerous disconnected efforts that make it appear more like a National Science Foundation-funded single investigator research effort than a focused center program.

Two specialists at the agency assist the project manager in monitoring the microelectronics, superconductivity, and advanced composite materials subprojects. The project manager generally makes site visits about twice a year to assess progress. In addition, the project manager reviews annual technical progress reports and financial status reports submitted by the university system. The project manager also frequently contacts university researchers by telephone to discuss progress and/or problems.

Center for Geosciences Research
at Colorado State University

ARO oversees this research center. The technical monitor is not fully satisfied with the progress of the Geosciences Center, and believes that while much of the center's specific research is good, the center has not

developed as it should have after 3 years of operation. The monitor said that centers funded under the URI Program, such as this one, should exhibit a kind of "synergism" in which specific research projects come together in such a way as to enhance all of the center's research activity. The technical monitor believes this has not happened at the Geosciences Center. Consequently, the center functions as a collection of individual research efforts. The monitor believes that the Army could just as easily fund such research on a project-by-project basis.

The monitor sent the director of the Geosciences Center a copy of the review and comments in a letter dated March 16, 1990. The monitor requested written responses to ensure that certain parts of the research that were not approved or funded were discontinued. The technical monitor stressed that the semi-annual report should give quantitative information about the research since such reports are one of the important ways to convey scientific and technical progress to Army researchers and laboratories. In addition, the monitor emphasized that phrases such as "the research is progressing well," or "the results are encouraging," or "the simulations went well," convey no substantive knowledge.

**Center for Study of Fast
Transient Processes at USC**

ARO also oversees this center. According to the technical monitor, the center at USC is an example of what a URI-funded center should be. For example, the technical monitor said the center maintains a close collaborative research effort with Army scientists at its own laboratories. The review panel and advisory committee's oversight meetings have resulted in uniformly positive comments about the nature and relevance of the center's research program. The center includes a significant university commitment in terms of matching fellowships, and a detailed fellowship recruitment selection and training program.

**Photonics Research Center at the
U.S. Military Academy at West
Point**

ARO oversees this research center. According to the technical monitor, this center was established to provide the Army with basic research and technology to train Army officers. A review group consisting of ARO's technical monitor and three university experts in the photonics area made a site visit to the Photonics Center in July 1989. Although the group was impressed with the enthusiasm of the people involved in the research, they did recommend some redirection of research tasks, including more emphasis on engineering by the optical processing group, and a higher risk research program by the group performing spectroscopy. The group also recommended that the Army obtain certain optical systems that could be evaluated by the West Point students as senior projects.

Appendix III
Army's and Defense Agencies' Oversight of
University Research Projects

ARO awarded the center a grant for the first and second years of the research period, but delayed providing additional funds in fiscal year 1990 because the center had not spent the funds appropriated for fiscal year 1989 by the end of that year. Subsequently, in April 1990, the technical monitor said the center would need additional funds during fiscal year 1991 because the center was currently spending its fiscal year 1989 funds. In fiscal year 1991, ARO plans to fund the center, though only at half the amount originally approved because the center is spending at only half the approved rate.

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